

Amendments to the Specification:

Page 1, please replace paragraph 3 with the following amended paragraph:

The cold rolled steel sheet manufactured by such a method is installed in a picture tube after ~~performed-being~~ treated by photo etching, annealing, pressing and baking. Unless carbon originally contained in the cold rolled steel sheet is decarbonized sufficiently during

Page 3, please replace paragraph 1 with the following amended paragraph:

~~Characterized of comprising~~comprises nitrogen equal to or less than 0.0030 wt%, boron satisfying an inequality of  $5 \text{ ppm} \leq B - 11/14 \times N \leq 30 \text{ ppm}$  and the residue including iron and unavoidable impurities. Shadow mask material according to the present invention ~~is characterized of comprising~~comprises carbon equal to or less than 0.0008 wt%, silicon equal to or less than 0.03 wt%, manganese from 0.1 to 0.5 wt%, phosphorus equal to or less than 0.02 wt%, sulfur equal to or less than 0.02 wt%, aluminum from 0.01 to 0.07 wt%, nitrogen equal to or less than 0.0030 wt% and boron satisfying an inequality of  $5 \text{ ppm} \leq B - 11/14 \times N \leq 30 \text{ ppm}$  and the residue including iron and unavoidable impurities.

Page 3, please replace paragraph 2 with the following amended paragraph:

A method for manufacturing shadow mask material made of a steel sheet according to the present invention is ~~characterized of comprising~~ nitrogen equal to or less than 0.0030 wt%, boron satisfying an inequality of  $5 \text{ ppm} \leq B - 11/14 \times N \leq 30 \text{ ppm}$  and the residue including iron and unavoidable impurities, wherein a hot rolling furnish is higher than a point  $Ar_3$ , comprises hot rolling the steel sheet ~~is hot rolled at~~ a coiling temperature from 540 to 680 °C. The sheet is then pickled, and cold rolled after pickling and then the steel sheet is annealed in a continuous annealing step so as to control ~~a content ratio of remained~~ the amount of carbon remaining as equal to or less than 0.0008 wt%.

Page 3, please replace paragraph 3 with the following amended paragraph:

A method for manufacturing shadow mask material made of a steel sheet according to the present invention is ~~characterized of comprising~~ carbon equal to or less than 0.0008 wt%, silicon equal to or less than 0.03 wt%, manganese from 0.1 to 0.5 wt%, phosphorus equal to

Page 4, please replace paragraph 1 with the following amended paragraph:

or less than 0.02 wt%, sulfur equal to or less than 0.02 wt%, aluminum from 0.01 to 0.07 wt%, nitrogen equal to or less than 0.0030 wt% and boron satisfying an inequality of  $5 \text{ ppm} \leq B -$

11/14 × N ≤ 30 ppm and the residue including iron and unavoidable impurities, wherein a hot rolling finish is higher than a point Ar<sub>3</sub>, comprises hot rolling said steel sheet ~~is hot rolled~~ at a coiling temperature from 540 to 680 °C. The sheet is then pickled, and cold rolled after pickling and then said steel sheet is annealed in a continuous annealing step so as to control ~~a content ratio of remained~~ the amount of carbon remaining at equal to or less than 0.0008 wt%

A shadow mask according to the present invention is characterized of comprising the above described shadow mask material.

A picture tube according to the present invention is characterized comprising the above described shadow mask.

Page 4, please replace paragraph 3 with the following amended paragraph:

Regarding chemical composition of the hot rolled steel sheet, the following chemical composition are preferable. That is, a steel sheet comprises nitrogen equal to or less than 0.0030 wt%, boron satisfying an inequality of  $5 \text{ ppm} \leq B - 11/14 \times N \leq 30 \text{ ppm}$  and the ~~residua~~ residue including iron and unavoidable impurity.

Page 5, please replace paragraph 1 with the following amended paragraph:

Nitrogen in steel makes nitride with aluminum. On the other hand, the aging effect of the steel is reduced by decreasing solid soluble nitrogen. Therefore, it is preferable that the amount of nitrogen ~~is as less~~ be as low as possible. In order to maintain the press forming characteristic as shadow mask material, it is necessary that the amount of nitrogen ~~is~~ be remarkably low and it is preferable that the upper limit ~~is~~ be 0.0030 wt%, more preferable 0.0020 wt%.

Boron:  $5 \text{ ppm} \leq B - 11/14 \times N \leq 30 \text{ ppm}$

Boron in steel uniforms crystal grain in a thin steel sheet so that excellent etching characteristic can be obtained as shadow mask material. Particularly, boron makes a big effect with respect to an extremely thin shadow mask having a thickness of 0.1 to 0.2 mm which has been used recently.

Page 5, please replace paragraph 2 with the following amended paragraph:

It is preferable that boron ~~is~~ be added ~~into to the~~ steel since boron is an effective element so as to fix solid soluble nitrogen. On the other hand, if an amount of boron is too much, crystal grains are extremely fine and its magnetic characteristic is adversely influenced ~~banefully~~. Therefore, it is preferable that ~~an~~ the amount of boron ~~is~~ be within a predetermined range.

Page 5, please replace paragraph 3 with the following amended paragraph:

In the present invention, it is preferable that the content of boron ~~is~~ be satisfied with the above inequality. If the content ratios of nitrogen and boron are within the above described ranges, respectively, an excellent etching characteristic can be obtained as shown in Fig. 1. Further, in the present invention, it is preferable that the following chemical composition of a hot rolled

Page 6, please replace paragraph 1 with the following amended paragraph:

steel sheet ~~are~~ be controlled, as a steel sheet having a thickness of 0.08 to 0.2 mm is suitable for an extremely thin shadow mask.

Page 6, please replace paragraph 2 with the following amended paragraph:

That is, ~~an~~ the content of carbon is equal to or less than 0.0030 wt%, ~~a~~ the content of ~~silicene~~ silicon is equal to or less than 0.03 wt%, ~~a~~ the content of manganese is from 0.1 to 0.5 wt%, ~~a~~ the content ratio of phosphorus is equal to or less than 0.02 wt%, ~~a~~ the content ratio of ~~surfer~~ sulfur is equal to or less than 0.02 wt% and ~~a~~ the content ratio of aluminum is from 0.01 to 0.07 wt%. The reason ~~ef~~ for the above ratios will be described hereinafter.

Page 6, please replace paragraph 3 with the following amended paragraph:

~~An~~ The amount of carbon in hot rolled steel sheet is much influenced ~~to~~ by a continuous annealing step for decarbonizing. If the content ~~ratio~~ of carbon exceeds 0.0030 wt%, carbon can not be decarbonized sufficiently in the continuous annealing step. To provide shadow mask material ~~of~~ in which a ~~the~~ content ~~ratio~~ of carbon is equal to or less than 0.0008 wt%, an annealing temperature has to be increased and an annealing time has to be extended. Therefore, ~~a~~ the manufacturing cost would become higher and a productivity would become lower. It is preferable that the upper limit ~~is~~ be 0.0030 wt%, more preferably 0.0020 wt%.

Page 6, please replace paragraph 4 with the following amended paragraph:

Silicon contained in shadow mask material is an element to prevent shadow mask material from ~~blackening~~ blackening in a ~~blackening-blackening~~ treatment for manufacturing a picture tube. Although the content ~~ratio~~ is ~~preferable-preferably~~ as less-low as possible, ~~silicone~~ silicon is an unavoidable element

Page 7, please replace paragraph 1 with the following amended paragraph:

~~as of~~ an aluminum killed steel. It is preferable that the upper limit ~~is be~~ 0.03 wt%, more preferably 0.02 wt%.

Page 7, please replace paragraph 2 with the following amended paragraph:

In hot rolled steel, manganese is necessary to prevent ~~silicone~~ silicon as an impurity from becoming red, thermal, and brittle in a hot rolling step. In the case of an extreme thin shadow mask material according to the present invention, the material is apt to be cracked in a cold rolling step. Therefore, it is preferable to add a predetermined amount of manganese. ~~A~~ The content ~~ratio~~ of manganese is preferably equal to or more than 0.1 wt%, more preferably equal to or more than 0.2 wt%, and further preferably equal to or more than 0.25 wt%.

On the other hand, the upper limit of the content ~~ratio~~ of manganese is preferably 0.5 wt%, more preferably 0.4 wt% and further more preferably 0.35 wt%, since the forming characteristic is ~~deteriorated~~ adversely affected if the content ~~ratio~~ exceeds 0.6 wt%.

Page 7, please replace paragraph 3 with the following amended paragraph:

In the shadow mask material, phosphorus reduces the size of crystal grains so that the magnetic characteristic becomes worse. It is preferable that the ~~content~~ ratio of

phosphorus ~~is be~~ as less low as possible. Particularly, in such an extreme thin shadow mask material according to the present invention, phosphorus is ~~baneful influenced~~ seriously adversely affected so that, the content ~~ratio~~ of phosphorus is preferably equal to or less than 0.02 wt%.

Page 8, please replace paragraph 1 with the following amended paragraph:

In hot rolled steel, sulfur is an unavoidable element and impurity so as to make the steel red, thermal, and brittle. It is earnestly preferable that ~~a the~~ the content ~~ratio~~ of sulfur ~~is be~~ as less low as possible. Particularly, in such ~~a~~ an extreme thin shadow mask material according to the present invention, the material is apt to be cracked in a cold rolling step. Therefore it is preferable to avoid sulfur as much as possible. To avoid the above phenomenon, the upper limit is preferably 0.02 wt%, more preferably 0.015 wt% and further more preferably 0.01 wt%.

Page 8, please replace paragraph 2 with the following amended paragraph:

In a step of manufacturing hot rolled steel, aluminum is added to ~~melt~~ molten steel as a deoxidizer and then removed as slag. Unless the added amount of aluminum is sufficient, a certain deoxidization effect can not be obtained. It is preferable that aluminum ~~is be~~ added



affirmatively so as to form aluminum nitride in a hot rolling step and an annealing step and to prevent solid soluble nitrogen from aging by fixing nitrogen. Particularly in the case of the extreme thin shadow mask material according to the present invention, the material is apt to be cracked caused by including impurity such as oxide in a cold rolling step. Therefore, it is necessary to add aluminum as much as possible. The lower limit is preferably 0.01 wt%, more preferably 0.02 wt%.

On the other hand, even if the content ~~ratio~~ of aluminum exceeds 0.07 wt%, the above effect can not be improved so much. Such redundant aluminum induces to increase recrystallization

Page 9, please replace paragraph 2 with the following amended paragraph:

A method for manufacturing an extreme thin shadow mask material according to the present invention will be described. Although a slab heating temperature and a hot rolling condition are not so restricted in the present invention, the slab heating temperature is preferably hotter than 1100 °C so as to keep a hot rolling temperature since a hot rolling property becomes worse if the slab heating temperature is less than 1100 °C. On the other hand, if the slab heating temperature is too high, nitride ~~is proceeded to~~

~~be dissolved~~disolves and becomes solid soluble again. The slab heating temperature is ~~preferable~~preferably less than 1220 °C.

Page 9, please replace paragraph 3 with the following amended paragraph:

If the hot rolling furnish temperature is equal to or less than  $Ar_3$ , crystal grains are mixed and become big in a crystal structure of a hot rolled steel sheet so that the etching characteristic and the press forming characteristic are deteriorated. The hot rolling furnish temperature is preferably higher than  $Ar_3$ .

Page 10, please replace paragraph 2 with the following amended paragraph:

Pickling and first cold rolling step may be normal conditions. In order to decarbonize and anneal an extreme thin shadow mask material according to the present invention effectively, ~~a~~the thickness of a steel sheet after the first cold rolling is preferably equal to or less than 0.6 mm and more preferably equal to or less than 0.5 mm.

Page 10, please replace paragraph 3 with the following amended paragraph:

A continuous annealing step is an important step in the present invention. The continuous annealing step is ~~preferable~~preferably operated in a condition wherein a sheet

temperature is equal to or more than 750 °C, a soaking period is equal to or more than 60 seconds, ~~a~~the ~~content ratio~~ of hydrogen is from 0 to 75 % and the residue is nitrogen gas in the annealing atmosphere and ~~a~~the dew point is from -30 °C to 70 °C.

Page 10, please replace paragraph 4 with following amended paragraph:

The annealing temperature ~~is influenced to~~ influences the decarbonization effect and the etching characterisitic. If the annealing temperature is less than 750 °C, it ~~spends~~ takes a long time to decarbonize. In addition to ~~reduce~~ reducing the productivity ~~a~~the structure of recrystallization after annealing becomes uneven so that a uniform etching characteristic can not be obtained. Accordingly, the annealing temperature is preferably equal to or higher than 750 °C.

Page 11, please replace paragraph 1 with the following amended paragraph:

Annealing time is preferably equal to or more than 60 seconds. If the annealing time is less than 60 seconds, the decarbonization with respect to the extreme thin shadow mask material is insufficient so that ~~a~~the content of the carbon can not be reduced to a target level equal to or less than 0.0008 wt%. Although the upper limit is not ~~necessary~~

necessarily restricted, the annealing time is preferably equal to or less than 120 seconds aspect from a point of the productivity and an avoidance of big grains.

If the content ~~ratio~~ of hydrogen gas in the continuous annealing atmosphere can be maintained equal to or less than 70%, a content ~~ratio~~ of carbon in the extreme thin shadow mask material can be reduced to a level equal to or less than 0.0008 %. Even if the content ~~ratio~~ of hydrogen gas exceeds 70%, the decarbonization time is not so changed and the manufacturing cost is increased. The upper limit of the content ~~ratio~~ of hydrogen gas is preferably 70%. In the case that the dew point is in a range from -30 °C to 70 °C, the content ~~ratio~~ of carbon in the extreme thin shadow mask material is equal to or less than 0.0008 %.

Page 11, please replace paragraph 1 with the following amended paragraph:

equal to or less than 40%, the necessary strength can not be obtained. If the rolling ratio is equal to or more than 91%, the number of rolling steps is increased and the productivity is reduced. Therefore, the upper limit is preferably 90%.

Through the secondary cold rolling, the furnish thickness of the extreme thin shadow mask material becomes from 0.1 to 0.2 mm.

Page 15, please replace paragraph 2 with the following amended paragraph:

When the shadow mask is fixed on the frame as described above, it is preferable that tensile force along a right-left direction of which amount is less than the tensile force along the upper-lower direction ~~is~~be loaded. In a picture tube according to the present invention, it is preferable that strong tensile force ~~is~~be applied along the upper-lower direction. In addition to the load in the upper-lower direction, the tensile force is loaded in the right-left direction. Thus the shadow mask can ~~prevent~~be prevented from crinkling by applying the tensile force along the upper-lower direction. However, if the large amount of tensile force were applied on the shadow mask along the right-left direction, slot holes formed on the shadow mask would be deformed.

Page 16, please replace paragraph 1 with the following amended paragraph:

nitrogen from occurring stretcher strain caused by aging solid soluble nitrogen and uniform recrystallization grains. In order to stabilize the etching characteristic, a necessary amount of boron is required to add to the material. However, if the added amount of boron is too much, high crystal grains become extremely fine so that the high qualification and the magnetic characteristic are ~~deteriorated~~adversely affected.